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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/643,980	08/20/2003	Shuji Hirao	60188-635	4984

7590 05/10/2005
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Washington, DC 20005-3096

EXAMINER

EVERHART, CARIDAD

ART UNIT	PAPER NUMBER
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2891

DATE MAILED: 05/10/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/643,980	Applicant(s) HIRAO ET AL.	
	Examiner Caridad M. Everhart	Art Unit 2891	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 4 April 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-35 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-25 and 27-35 is/are rejected.
- 7) ☒ Claim(s) 2 and 26 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

Withdrawal of Finality

Applicant's request for reconsideration of the finality of the rejection of the last Office action is persuasive and, therefore, the finality of that action is withdrawn.

The indicated allowability of claims 1-23 is withdrawn in view of the newly discovered reference(s). Rejections based on the newly cited reference(s) follow.

Applicant's arguments with respect to claims 1,2,5-10,12-25,27-33, and 35 have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1, 2, 5,6,7,9,10, 12, 13, 15-17, 19-25,28-30, 32, 33, and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Blish, II, et al. (US 5,882,738) in view of Fiordalice, et al (US 5,420,072) and further in view of Snyder, et al (US 6,646,346B1).

Blish, II, et al. discloses a method for forming a semiconductor device(col. 1, lines 19-20). The steps include forming a barrier layer such as TiN (col. 1, lines 57-60) and forming a layer of amorphous material such as tantalum or titanium, which is the first conductive film, on which to deposit metal such as copper or aluminum, which is the

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second conductive film(col. 2, lines 58-67 and col. 3, lines 4-5). Bliss, II et al further disclose that the barrier may be other materials with similar properties to those given as examples(col. 5, lines 33-37). There is a heating step(col. 5, lines 5-9).

The resulting metal layer has the desired crystal(called texture) structure(col. 2, lines 57-62). Sputtering or CVD may be used to deposit the first conductor as well as the barrier(col. 1, lines 57-67 and col. 2, lines 1-4)PVD or CVD may be used to deposit the second conductor(col. 4, lines 64-67). The heating is at a temperature lower than $\frac{1}{3}$ the melting point of the first conductive film(col. 5, lines 35-40), as the first conductive film is a high-melting point metal with melting point greater than 1500 degrees C(col. 2, lines 65-67 and col. 3, lines 1-3) and the heating is at less than 450 degrees C. With respect to the limitation of absolute temperature, because the absolute temperature is related to the Celsius scale by an constant amount, it is believed that the limitation is still satisfied by the disclosure made by Blish, II et al, since all of the temperatures would be offset by the same amount. The limitation of claim 3 that the first conductive film is formed of a metal mainly containing copper is satisfied by the disclosure that the first conductor can be made amorphous by the implantation of copper when the second conductor is copper(col. 3, lines 27-37), since the first conductor can be tantalum implanted with copper, which would satisfy the limitation mainly containing copper, since the only species implanted into the tantalum would be copper. With respect to the forming of the layers in a concavity, Bliss II, et al disclose that the layers can be formed in a contact opening(col. 1, lines 50-63).

Blish, II, et al does not state that the barrier has a crystal structure , although it is implied by the disclosure that there is a step for causing the formation of an amorphous layer(col. 2, lines 52-67), which implies that the barrier has a crystal structure.

Blish, II, et al is silent with respect to the integration of the first and second conductive films, although Blish, II, et al does have a heating step. Blish, II, et al also does not teach the recited thicknesses.

Fiordalice, et al discloses that TiN can be formed with preferred crystal structure(col. 3, lines 38-43).

It would have been obvious to one of ordinary skill in the art at the time of the invention that the barrier taught by Bliss, II et al has a crystal structure in view of the disclosure made by Fiordalice, et al because this is implied by the disclosure made by Bliss, II et al as cited above, and because the method of deposition cited above would have resulted in crystal structure, as made clear by the disclosure made by Fiodalice, et al.

Snyder, et al disclose providing a titanium layer , an aluminum layer, and a titanium nitride layer and alloying the titanium with the aluminum(col. 4,lines 32-35 and col. 5,lines 10-14 and 43-45). Snyder, et al also discloses that the thickness of the layer to be alloyed can be determined(col. 4, lines 33-48) and that the thickness depends upon the needs of the particular application(col. 6, lines 1-7).

Although Blish, II, et al is silent with respect to the first and second conductor layer becoming one layer, it would have been obvious to one of ordinary skill in the art at the time of the invention that the first and the second layer taught by Blish II, et al

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become one layer because Snyder, et al teach that Ti would diffuse into the second metal layer.

It would have been obvious to one of ordinary skill in the art at the time of the invention to have formed the layers in the recited thicknesses because the thickness of the layers is a variable of the art which one of ordinary skill in the art would be able to determine. This is supported by the disclosure of Snyder cited above, that the thickness depends upon the needs of the particular application.

Claims 4,14, 18, and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bliss II et al in view of Fiordalice et al and further in view of Snyder et al as applied to claim1 above, and further in view of Ouellet(US 5,747,361).

Bliss II et al in view of Fiordalice et al and further in view of Snyder et al is silent with respect to the resistivity before heating the layers.

Ouellet discloses that the resistivity of interface between TiN and aluminum, at which there is some titanium is in a range greater than that recited in the above claims(col. 19, lines 25-43).

It would have been obvious to one of ordinary skill in the art at the time of the invention that the resistivity of the interconnect layers taught by Bliss, II, et al in view of Fiordalice et al and further in view of Snyder et al would be greater than the recited range because the layers taught by Bliss, II et al in view of Fiordalice et al and further in view of Snyder et al are similar to those taught by Ouellet.

Claims 8 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bliss II et al in view of Fiordalice et al and further in view of Snyder et al as applied to claim 1 above, and further in view of Kausche, et al (US 4,020,222).

Bliss II et al in view of Fiordalice et al and further in view of Snyder et al is silent with respect to the structure of the tantalum layer.

Kausche, et al discloses that beta tantalum results from sputter deposition of tantalum(col. 1, lines 40-50).

It would have been obvious to one of ordinary skill in the art at the time of the invention to have used beta tantalum in the invention taught by Bliss II et al in view of Fiordalice et al and further in view of Snyder et al because Bliss II et al teach that the tantalum may be sputtered, as cited above.

Allowable Subject Matter

Claims 3 and 26 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The prior art of record does not teach or suggest the recited resistivity.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Caridad M. Everhart whose telephone number is 571-272-1892. The examiner can normally be reached on Monday through Fridays 7:30-4:00.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, B. Baumeister can be reached on 571-272-1722. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



**CARIDAD EVERHART
PRIMARY EXAMINER**

C. Everhart
5-6-2005